

OV AND HARD X-RAYS, OBSERVATIONS AND MODEL CALCULATIONS

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Abstract

This paper is an amalgamation of two published works that discuss the observation and theoretical calculations of OV (T~250,000K) and Hard X-rays (30-100keV) emitted during flares. The papers are by Poland et al (1984) and Mariska and Poland (1985). The observations of Hard X-rays and OV show that the excitation processes for each type of emission are closely coupled. Except for small differences the two types of emission rise and fall together during a flare. Model calculations are able to reproduce this behavior to a large extent, only when conductive processes do not dominate the energy transport processes.

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Discussion of Figures

Figure 1 shows the light curves for one flare in OV and HXR. The upper curve shows emission in OV for the entire flare area as a function of time (actual values are 10^{23} times larger than shown), while the lower curve shows HXR emission above 25keV (actual values are 3.84×10^{20} times larger than shown). The noise errors for a single measurement are shown as vertical bars. It can be seen from this figure that OV and HXR peaks occur simultaneously and that OV and HXR rise and fall together.

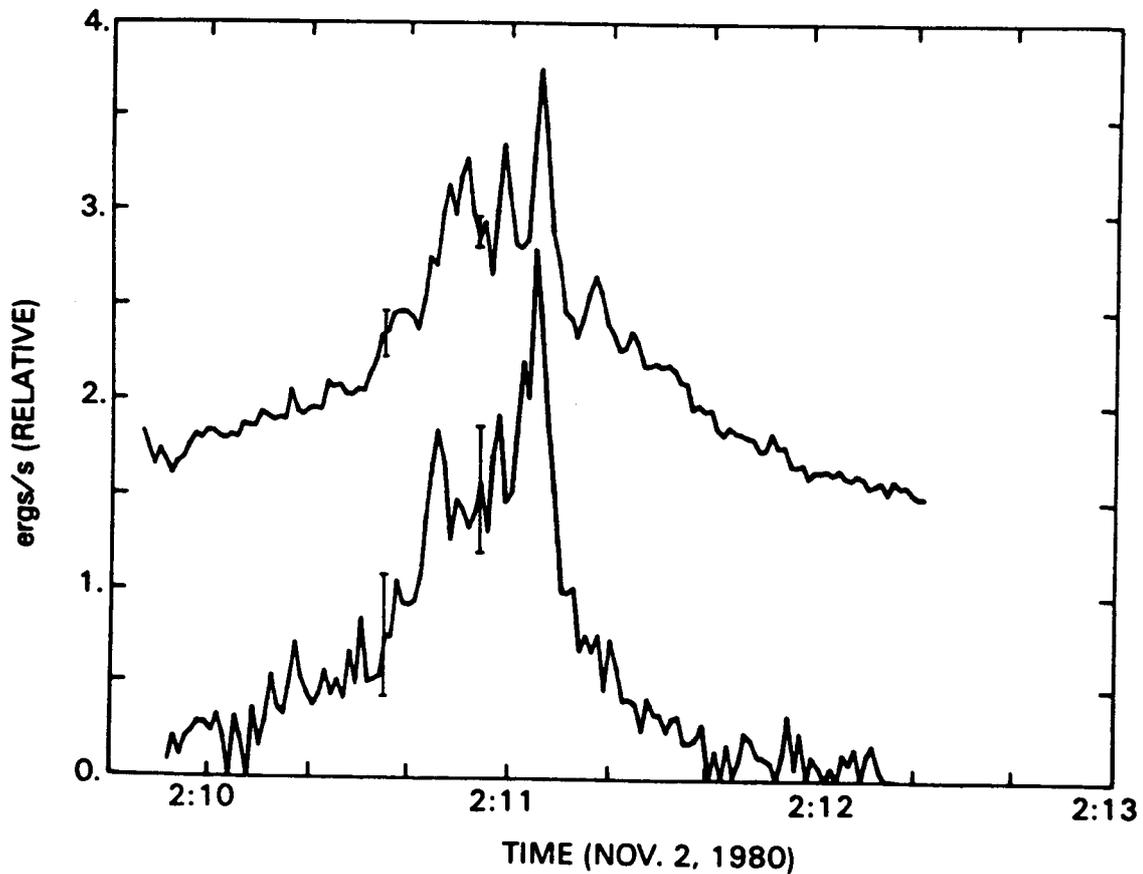


Figure 1

Figure 2 shows the energy emitted in HXR as a function of energy emitted in OV on a log - log scale. Squares are before flare maximum, diamonds are within 5 s of maximum, and plus signs are after flare maximum. Only every third point has been plotted for clarity of the figure. It can be seen that for this flare they both rise and fall together and peak at the same time. There has been some discussion in the past about the importance of the slope of this curve and the large change in HXR for a small change in OV. First, it can be seen from Figure 1 that most of the range of HXR in Figure 2 is from the lowest brightnesses and may be due mostly to noise. Second, the lowest brightnesses of OV are highly influenced by the size of the area chosen for measurement and the background brightness. Only the brightest few points have a significantly measurable slope which is not clearly unique, so the physical significance of this is unclear. The significant result is that HXR and OV rise and fall together with only a small hysteresis.

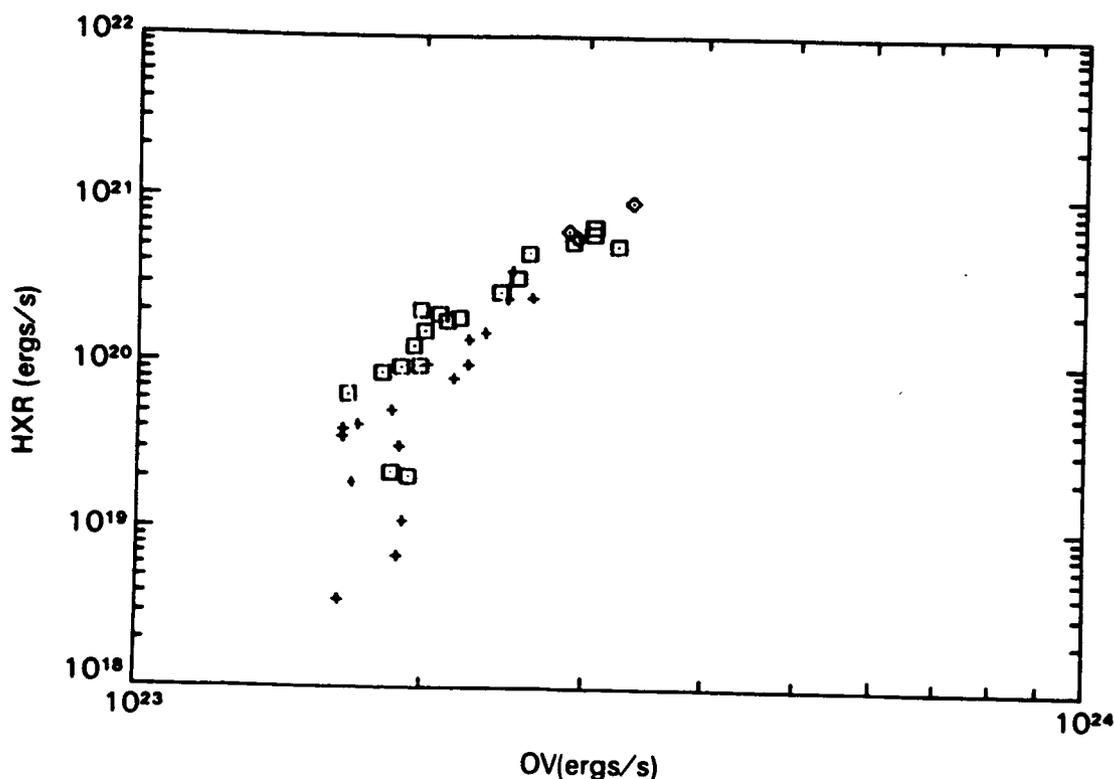


Figure 2

Figure 3 shows a plot similar to Figure 2 for several flares. Note that while most flares rise and fall together some show a lag in the fall of OV. This lag behavior is what is expected when conduction begins to become an important factor in the energy transport. The numbers refer to the flare number (see Poland et al 1984). Curves labeled with a solid line are disk flares; -.- are limb flares; and - - - are on the disk but near the limb. Arrows on the split curves show the direction in time. Number 7 is the same flare shown in Figures 1 and 2.

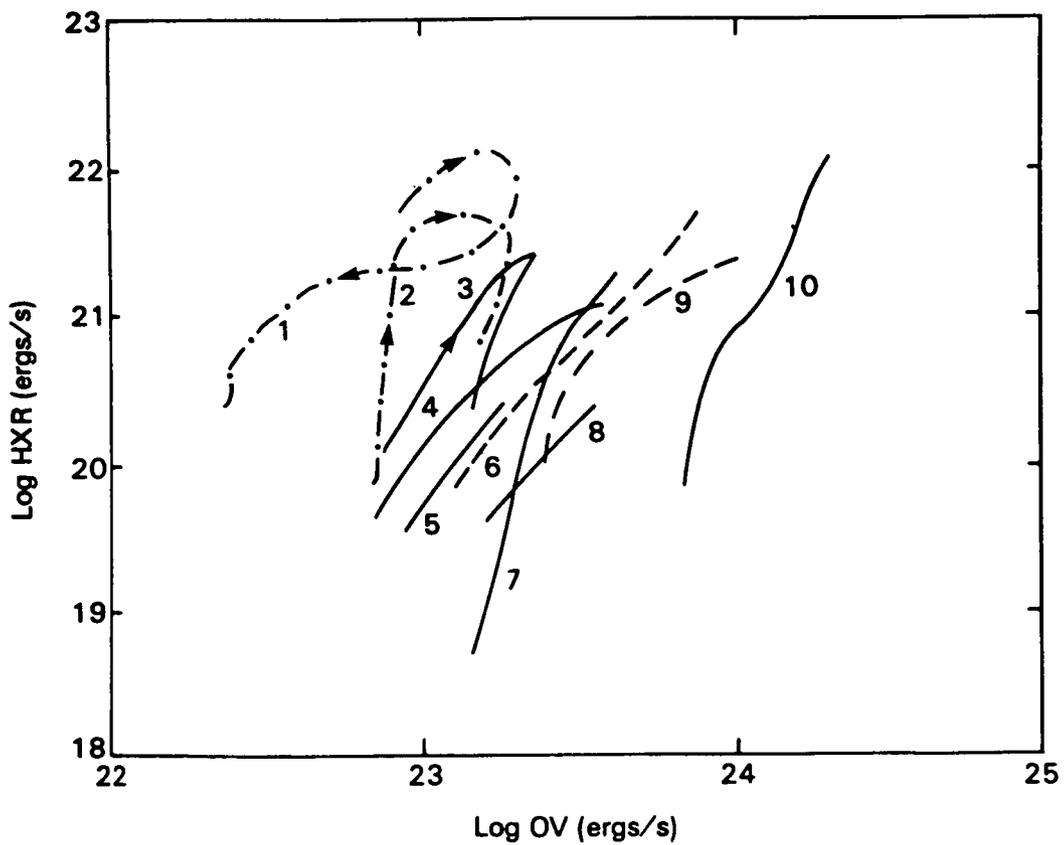


Figure 3

Figures 4 and 5 show the effect of heating location on the model calculations. We plot temperature vs. column mass with the temperature of OV formation bracketed by the two horizontal lines. Time evolution is shown by the numbers 0., .5, 1. etc.. It can be seen that when heat is deposited below the transition region (a) there is obviously an enhancement of OV until later times when the temperature gradient steepens due to conduction. Even at these later times OV is enhanced because Ne^2 dominates the smaller Δm . In the case where heat is deposited above the transition region (b) it is not obvious that OV is enhanced. The steepening temperature gradient reduces Δm but because the transition region is driven deeper into the atmosphere Ne^2 increases. Detailed calculations show that it increases in this case also but the results are highly model dependent. Once the heat source is turned off in these cases OV does not immediately decrease because conduction continues to supply heat from the now enhanced corona or flare loop.

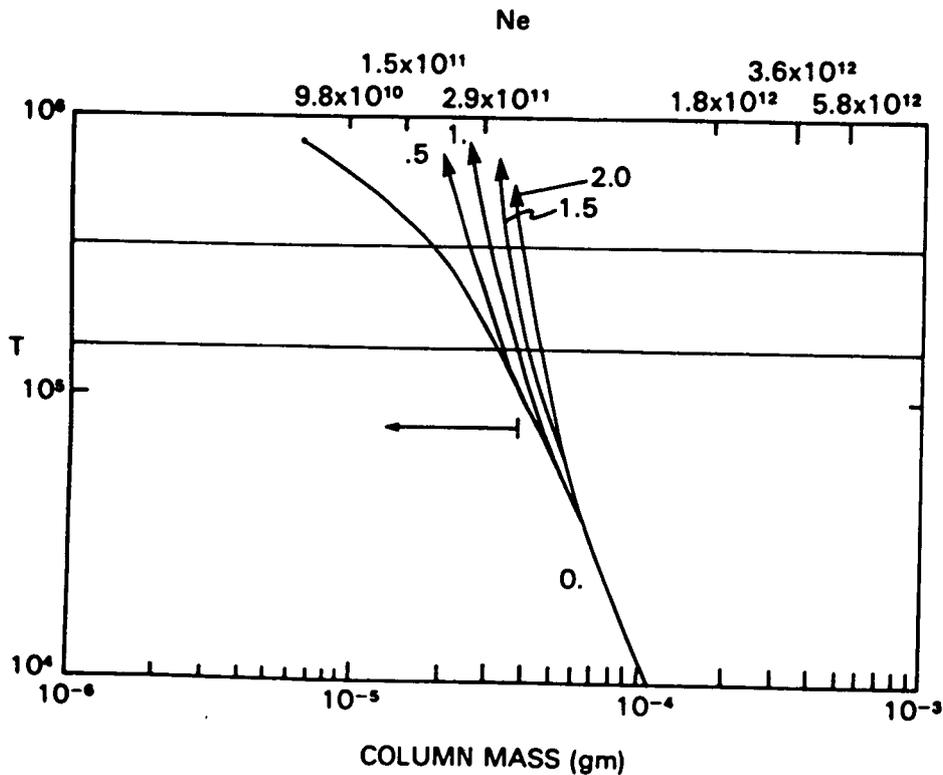


Figure 4

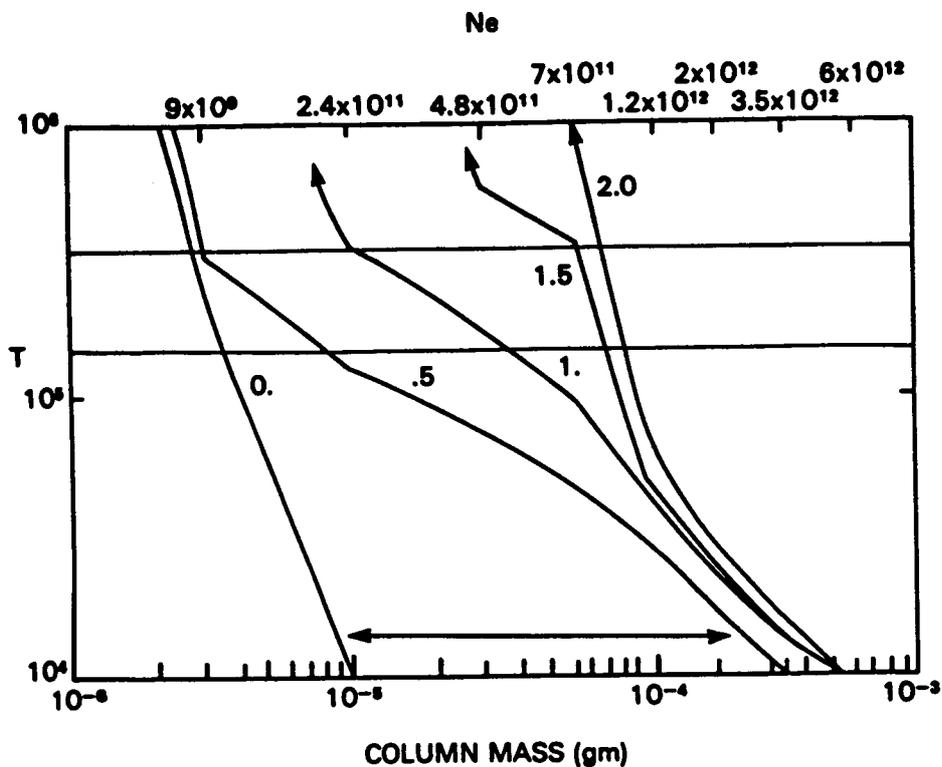


Figure 5

Figure 6 shows the more detailed calculations discussed in Mariska and Poland (1985). The figure shows temperature and emission measure distributions at various times during the flare for one model. The order of the times listed on the left panels corresponds to the ordering in temperature of the peaks in the 1600km region and the ordering of the emission measure curves between $\log T$ of 4.8 and 5.0. For clarity the plots are separated into pre and post maximum sections. The initial model parameters are indicated in the upper left panel.

Figure 7 shows the relation between the power emitted in HXR and the power emitted in OV 1371 A for the four different combinations of initial pressure and beam flux discussed in Mariska and Poland (1985).

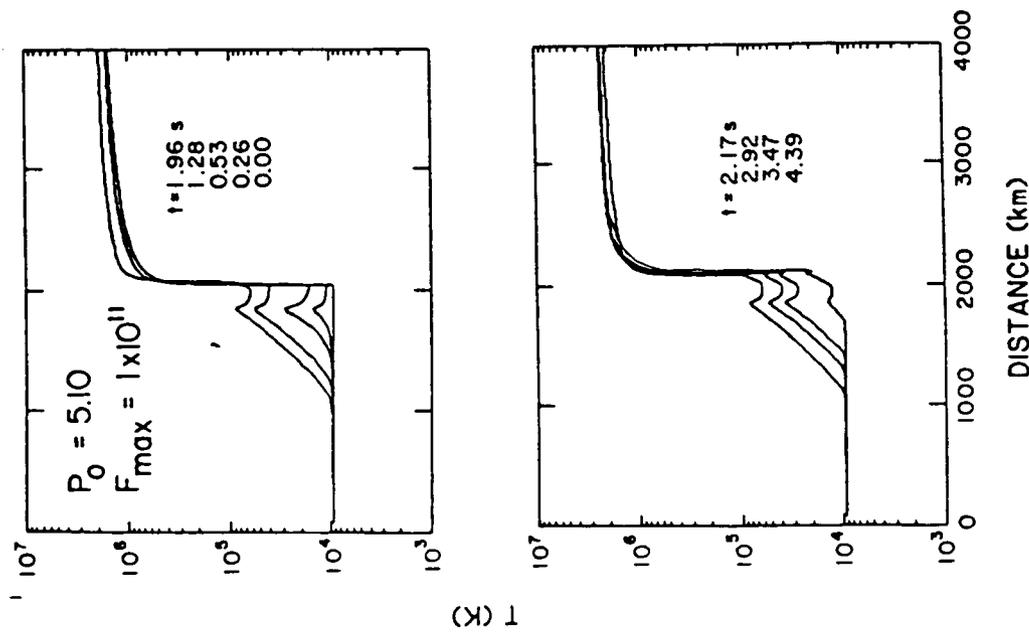
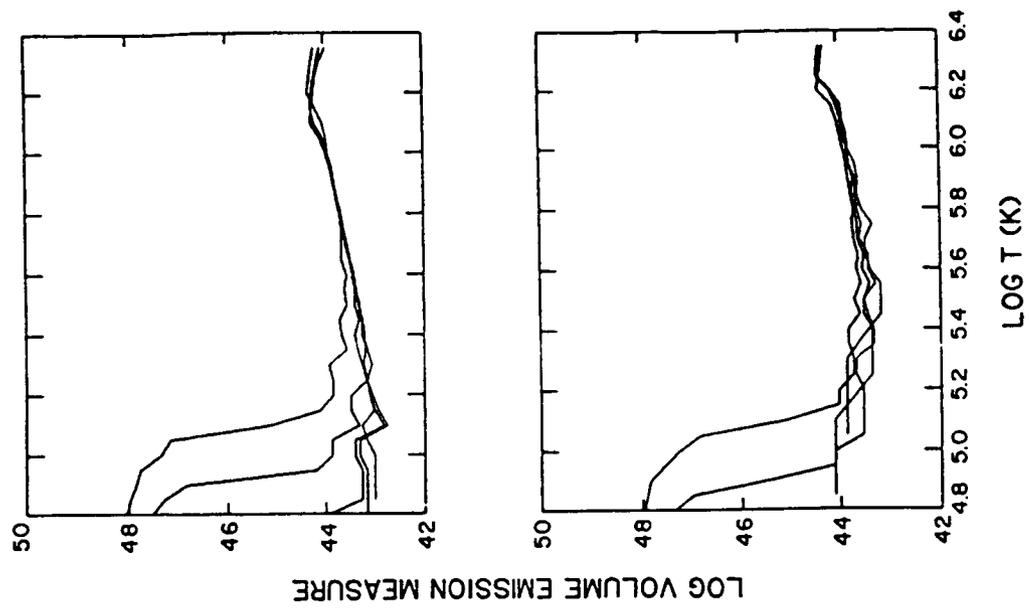
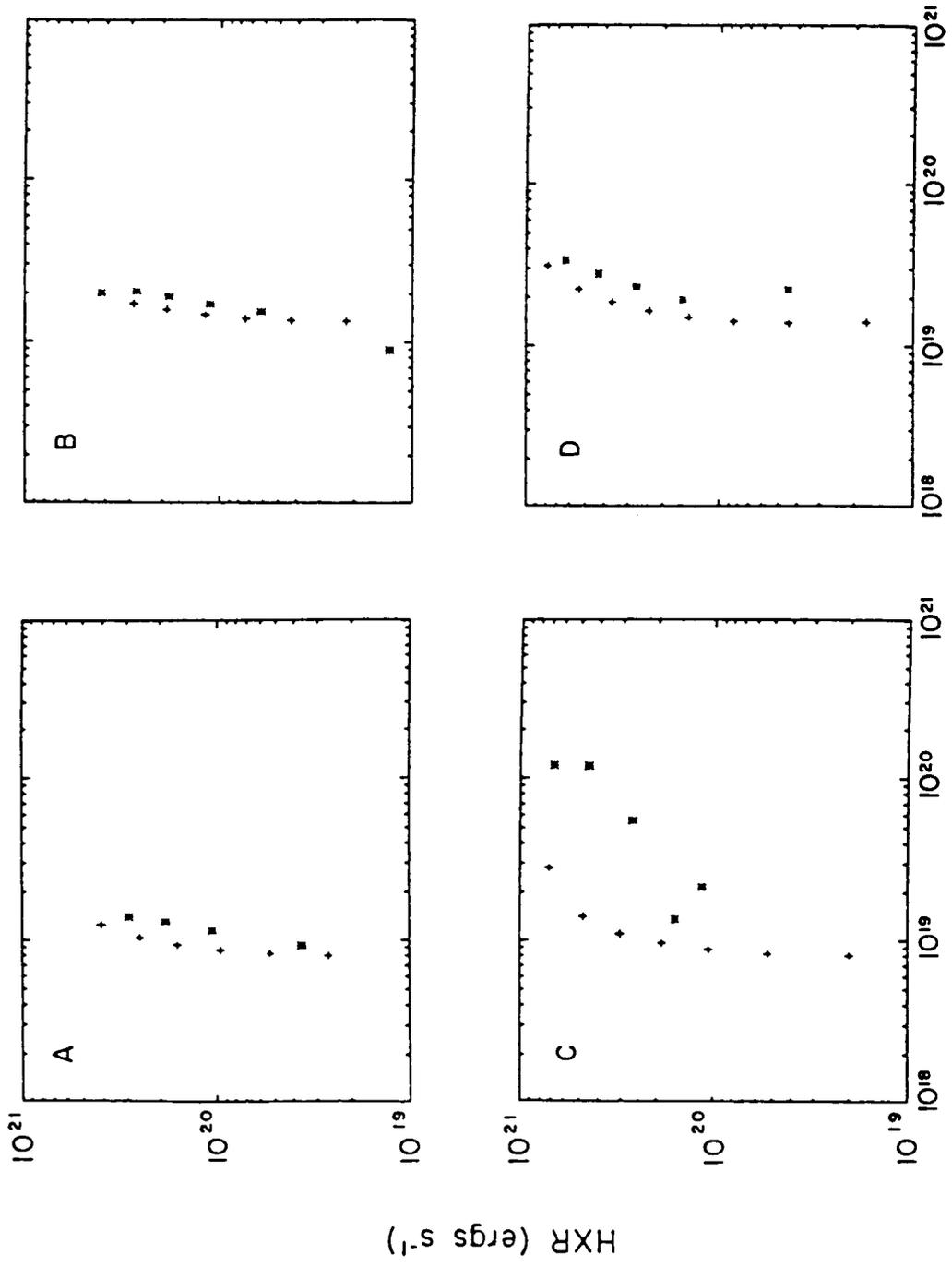


Figure 6



OV 1371 Å (ergs s⁻¹)

Figure 7

Premaximum points are indicated with pluses and postmaximum points are indicated with stars. The time separation between each point is roughly 0.25s. This figure shows that to avoid the hysteresis observed in case c, it is essential that conduction not become the dominant source of enhanced heating. This required a relatively high density, and a short heat input. If the heat input is long and of low energy, temperature enhancements in the chromosphere will be of too low a value to provide the observed enhancements.

Conclusions

We can think of few possibilities that would allow the OV and HXR to follow each other as is observed. These are: 1) The impulsive phase loops are separate from the gradual phase loops and do not reach temperatures greater than approximately 2×10^6 K. There are many loops each "firing" for a second or two and relaxing for several seconds before "firing" again. 2) Conduction is almost totally inhibited so that the transition region is heated only directly by the electron beam.

Acknowledgments

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References

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